

CRN - DoE MICROTURBINE DEMONSTRATION PROGRAM

**Cooperative Research Network
of the National Rural Electric Cooperative Association**

Peer Review of Microturbine Programs
Fairfax, VA March 13, 2002
Ed Torrero, CRN Arlington, VA

Rural Co-operatives . . .



- 1000 co-ops in 46 states
- 10% of power supply, 30 GW
- 45% of distribution lines, 75% of land mass
- 13+ million service connections, 34 million customers
- 60% residential, 35% commercial/industrial load

DoE Microturbine Demo Program Objectives . . .

- Collect test and operation information on installation and performance by NRECA participants**
- Identify developmental needs re: permitting, interconnection and building code compliance**
- Identify developmental needs re: technology, maintenance and operation**
- Provide technology baseline to benchmark future improvements**

Co-op Participants . . .



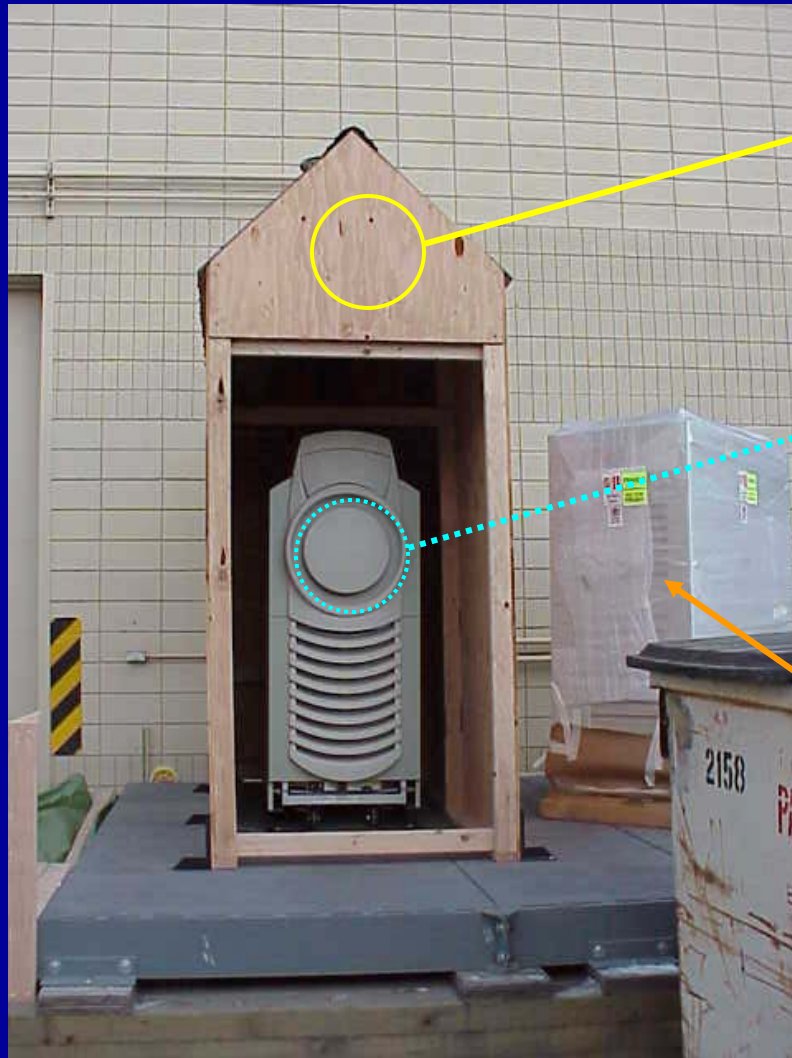
Demonstration Features . . .

- **Sound cross section of manufacturers**
 - 5 Capstones
 - 2 Elliotts
 - 1 Honeywell
 - 1 Ingersoll-Rand
- **Multiple fuels**
 - Low pressure natural gas
 - Fuel Oil
 - Propane
- **Thermal recovery**
- **Grid-Independent and Grid-Parallel operation**
- **Baseload and simulation of remote grid dispatch**
- **Simulation of SCADA integration**

Program Characteristics . . .

- Multiple units at diverse sites operated by “real” co-op users
- Significant leveraging of funds
 - EPRI / CRN
 - CRN
 - CO-OPS
 - DoE
- Key CRN crosscheck access to parallel EPRI MT demonstration program

Gas Fired Capstone at Chugach Site . . .



- **Wooden enclosure halved troublesome tone noise to nearby residences**
- **Capstone now has a silencer retrofit kit for inside the micro-turbine cabinet**
- **Oil fired Capstone awaiting installation**

Photo courtesy of Chugach Electric Association
Anchorage, AK

Typical Co-op Reporting (Chugach) . . .

**Microturbine Demonstration Program:
Installation Letter Report**

Your Company Name? Chugach Electric Association
 Contact person for this report? Peter Poray, PO Box 196300, Anchorage AK 99519,
 ph 907-762-4788, fax 907-762-4816
 Name and address of selected site? AVEC, 4831 Eagle St. Anchorage, AK 99503
 Type of business at selected site? office & warehouse,
 Microturbine and features to be demonstrated at this host site? Capstone, oil fired, no
 cogen, grid parallel and grid independent
 Turbogenerator physical installation at site?
 Capstone unit on steel pad, electrical connection to main electrical panel inside building,
 space on pad for an oil fired Capstone unit.
 Pictures provided in earlier reports.
 Altitude (feet)? 70
 Electrical Interconnect
 -Voltage? 208 V 3 phase
 -Site kW and kWD loads? 80 to 100 kW; 20,400 to 35,000 kWh per month.
 -Present power and load factors? PF 95%; LF 35 to 48%
 -No anti export, Chugach revenue meter records both in and out power flow
 -Grid Independent planned for testing, not wired for powering panels in GI testing and will
 run a load bank or resistance heaters.
 * Type of loads? Typical office and warehouse loads, some small shop welding and air
 compressor equipment in warehouse
 * Did customer load have to be segregated to match turbine capacity? No, will run load
 bank in GI mode.
 * What kind of grid isolation device was used? 100A-480v-4SN-SW fused disconnect
 SquareD.
 Fuel: Oil
 - #1 diesel fuel
 -Density or specific gravity? .81
 - Heating value Btu/gal. 132,000
 - Sulfur % wgt. 3 max
 -Cost per million Btu? \$10
 -Is supply firm or interruptable? Firm
 Thermal Recovery (if any) N/A

Thermal Recovery

Heat exchanger at microturbine exhaust

Sub-total

Thermal Recovery

Heat exchanger at microturbine exhaust

• Interconnect

- 130 feet; 480 to 208 3-Ph via transformer
- 170 feet to new 15 psig NG, New oil tank

• Costs: Demo and Com'l

	Natural Gas	Fuel Oil
Actual Demonstration:		
Engineering	\$4,670	\$10,200
Permitting	3,300	560
Fuel	2,950	11,230
Electrical	9,500	9,500
Thermal Recovery	NA	NA
Total	\$20,420	\$31,490

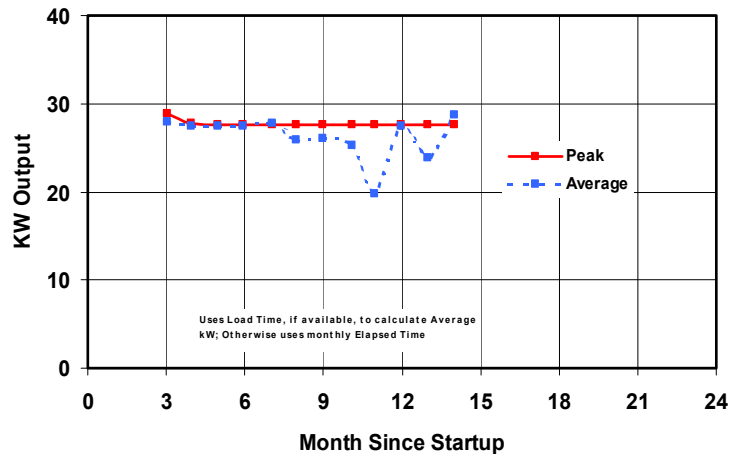
Projected if Full Commercial unit at customer site:

\$8,250 \$18,120

**Site Installation Letter Report
and Cost Spreadsheets**

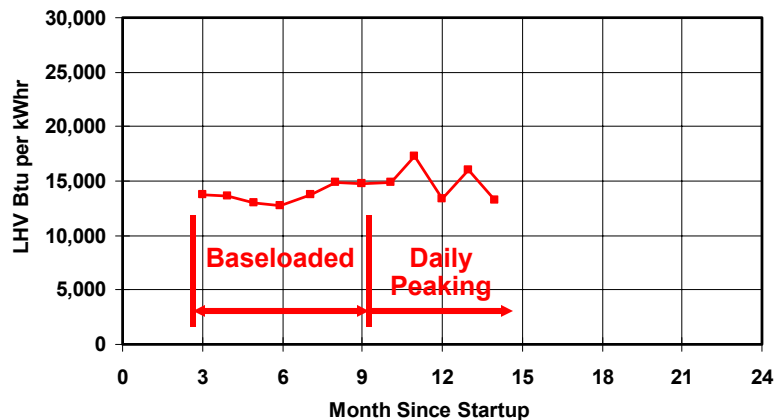
Typical Co-op Reporting (Chugach) . . .

Peak and Average Monthly Output

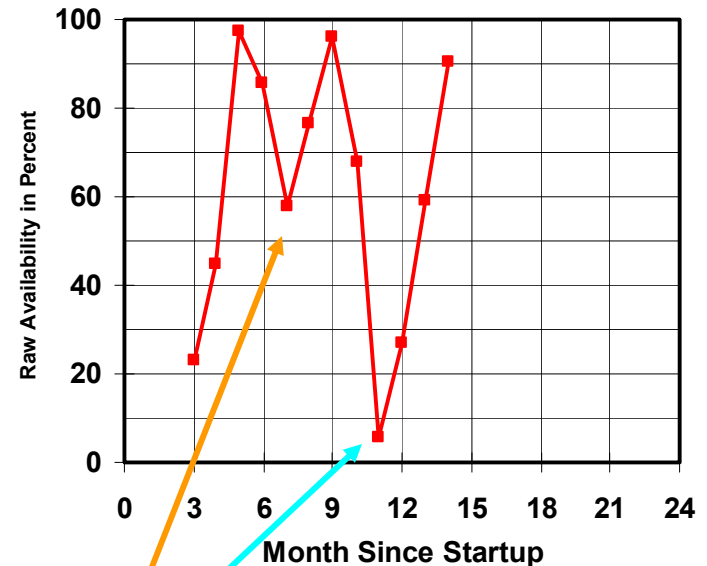


Heat Rate by Month

No Credit For Any Thermal Recovery



Raw Availability By Month



Reduced availabilities due to replacements of Rotary Fuel Compressor, etc. New air bearing design should enhance availability.

Gas Fired Capstone at Cass County Site . .

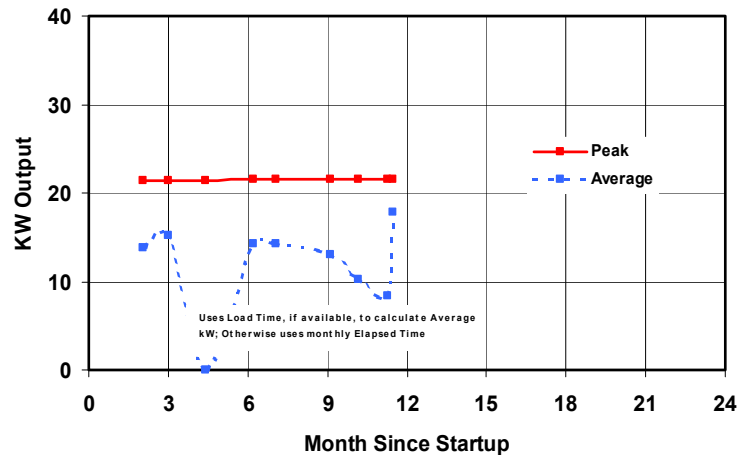


CRN Demo Unit installed at Cass County

- Located at Holiday Inn in North Dakota
- Natural Gas at 11 psig - Runs Grid Independent
- Electric output powers an electric water heater!
- Thermal recovery is for additional water heating

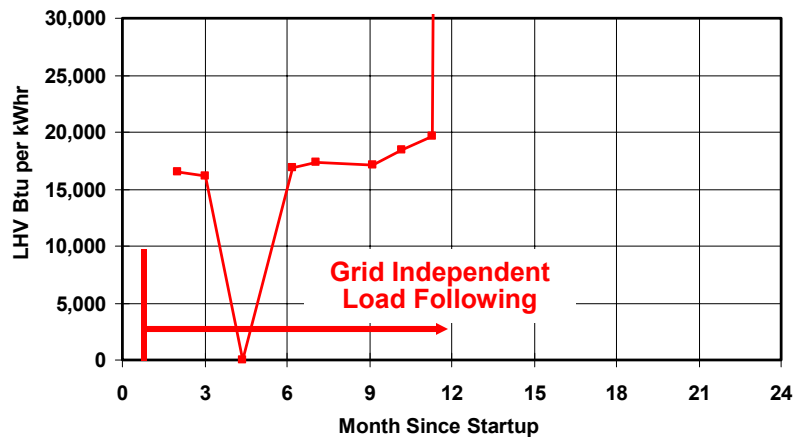
Typical Co-op Reporting (Cass County) . . .

Peak and Average Monthly Output

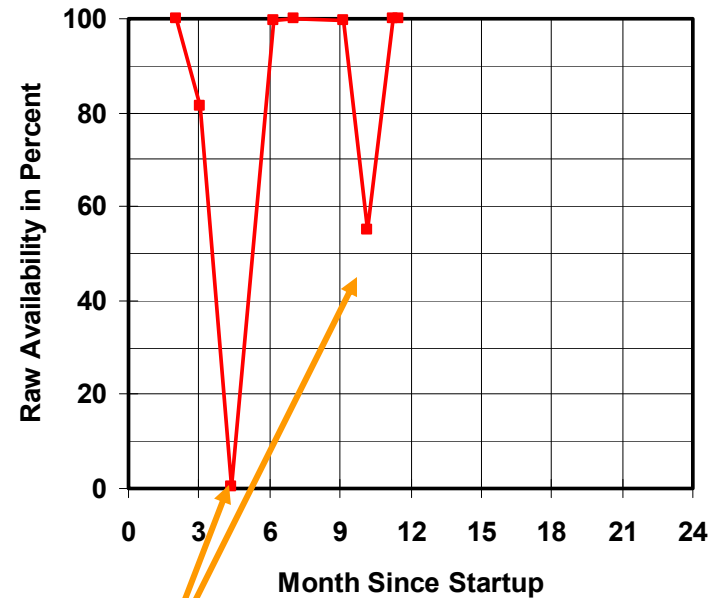


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Technology Bottom Line . . .

- **No endemic technology failures to date (microturbine power assembly, recuperator, etc).**
- **Efficiencies about as represented.**
- **Capstone perhaps most “commercial” but all manufacturers beset by peripheral issues.**
- **Areas where design enhancements needed:**
 - Fuel gas compressor likely to remain a high-maintenance item and energy consumer (~5 to 7% of kWh)
 - Limited motor start capability constrains Grid Independent use
 - Inverters may need more “hardening” relative to grid

Typical Equipment and Installation Costs . . .



Doubling the Size: Reduces Equipment Cost per kW by 20%
Reduces Installation Cost Component per kW by 35%

How Does Cost Stackup?

Cost to Customer (Cents / kWh)

	Rural Co-op	IOU Electric	Customer Owned
Peaking @ 1,500 Hours per year			
Owning Cost	14.3	20.3	24.6 to 34.2
\$6 /MilBtu NatGas* + 1.5¢ Maint	8.6	8.6	8.6
Total	22.9	28.9	33.2 to 42.8
BaseLoad @ 95% avail = 8,322 Hours per year			
Owning Cost	2.6	3.7	4.4 to 6.2
\$6 /MilBtu NatGas* + 1.5¢ Maint	8.6	8.6	8.6
Total	11.2	12.3	13.0 to 14.8

* \$1.20 / gallon Fuel Oil is equivalent to \$8.65 per million Btu Natural Gas ...and... \$1.10 per gallon Propane is equivalent to \$12 per million Btu Natural Gas

Basis: Excludes cogeneration credit which at full thermal recovery could reduce busbar costs 2.5 ¢/kWh for gas price of \$6.00 per MilBtu.

\$1,100 / kW equipment plus \$275 / kW installation

10-Year equipment life

14,200 HHV Btu / kWh heat rate

Maintenance at 1.5 cents per kWhr

Debt is at 9% were applicable

Utility ROE is 18%

Customer Owned ROE is 25% → 3.3 Yr Payback

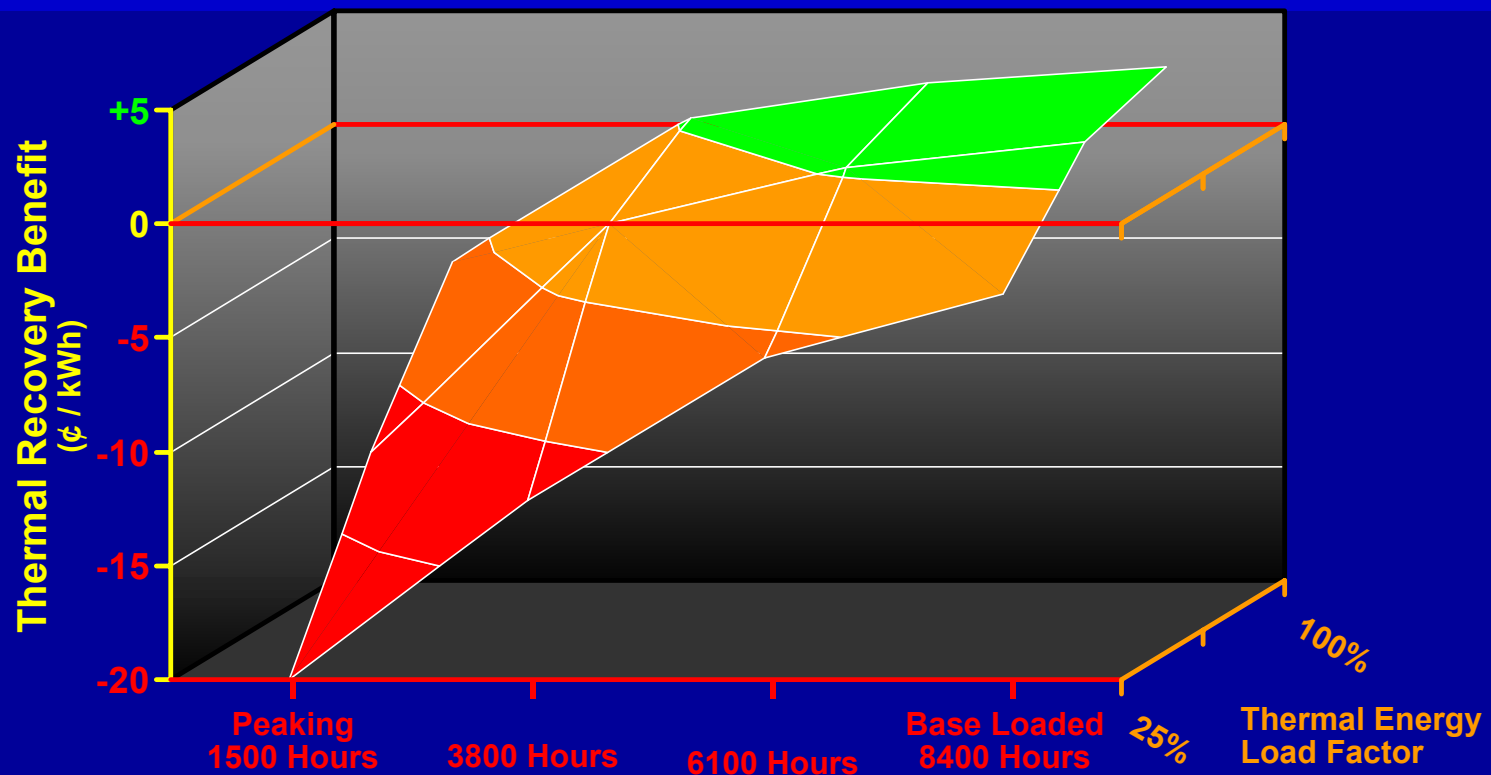
Range is w w/o debt financing

7-Year MACRS for FIT where applicable

No Investment Tax Credit

Combined FIT + State Income Tax rate is 41.5%

Thermal Recovery Attractiveness?



- Unless electric thermal displaced, cost effective thermal recovery requires base loaded operation and maximum thermal use. ➡ **Applicable sites limited!**
- Thermal recovery Installation Cost can quickly spiral if every last Btu chased.

*Basis: \$25,000 cost to install 330,000 Btu/Hour Thermal Recovery at a 60 kW microturbine site
Customer owns thermal recovery equipment and requires a 3.3 year payback
Displaced thermal use was fueled by \$6 natural gas at a 75 percent combustion efficiency*

A satellite night view of North America, showing the continent illuminated by city lights against the dark background of the oceans. The lights are concentrated in the eastern half of the continent, particularly in the United States and Mexico.

Thank You

Courtesy NASA